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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

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**Declarations under Rule 4.17:**

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)*

— *of inventorship (Rule 4.17(iv)) for US only*

**Published:**

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— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

(54) Title: OXIDATION PROCESS FOR THE PRODUCTION OF CARBOXYLIC ACIDS AND ALKENES

(57) Abstract: An oxidation process for the production of alkenes and carboxylic acids from a feed comprising alkene and/or alkane, carbon monoxide, a molecular oxygen containing gas and optionally water in the presence of an oxidation catalyst in which the level of carbon monoxide is maintained between 1% and 20% by volume of the total feed to the reactor.

WO 2004/108649 A3

# INTERNATIONAL SEARCH REPORT

Int Ional Application No
PCT/GB2004/002069

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C07C51/215 C07C51/25 C07C67/05 C07C67/035 C07C53/08
C07C69/01 C07C69/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C07C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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| X | WO 01/90043 A (ZEYSS SABINE ; AVENTIS RES & TECH GMBH & CO (DE); DINGERDISSEN UWE (DE) 29 November 2001 (2001-11-29) | 1,2,4-9, 13,16-33 |
| Y | *the whole document; in particular, page 7, last paragraph; page 8, last paragraph; page 9, first paragraph; page 11, last paragraph; page 13, last paragraph and the tables* | 3,10-12, 14,15 |
| X | WO 01/90042 A (ZEYSS SABINE ; AVENTIS RES & TECH GMBH & CO (DE); DINGERDISSEN UWE (DE) 29 November 2001 (2001-11-29) | 1,2,4-9, 13,16-33 |
| Y | *the whole document; in particular, page 5, last paragraph; page 9, lines 20-25 and the tables* | 3,10-12, 14,15 |

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 9 December 2004 | 17. 01. 2005 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL – 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Lorenzo Varela, M.J. |

Form PCT/ISA/210 (second sheet) (January 2004)

# INTERNATIONAL SEARCH REPORT

national application No.
PCT/GB2004/002069

**Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1,2,4-22(part),23,24-33(part)

Process for the oxidation of a C2 to C4 alkane to produce the corresponding alkene and carboxylic acid and/or for the oxidation of a C2 to C4 alkene to produce the corresponding carboxylic acid, the process comprising feeding to an oxidation reaction zone said alkane and/or alkene, a molecular oxygen-containing gas, carbon monoxide and optionally water, in the presence of a catalyst to produce a first product stream containing alkene and carboxylic acid, characterised in that said carbon monoxide is maintained at between 1% and 20% by volume of the total feed to the oxidation reaction zone and possibly further comprising contacting in a second reaction zone at least a portion of said alkene and at least a portion of said carboxylic acid obtained from the oxidation reaction zone and a molecular oxygen-containing gas, in the presence of a catalyst to produce a second product stream comprising alkenyl carboxylate.

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2. claims: 3,4-22(part),24-33(part)

Process for the oxidation of a C2 to C4 alkane to produce the corresponding alkene and carboxylic acid and/or for the oxidation of a C2 to C4 alkene to produce the corresponding carboxylic acid, the process comprising feeding to an oxidation reaction zone said alkane and/or alkene, a molecular oxygen-containing gas, carbon monoxide and optionally water, in the presence of a catalyst to produce a first product stream containing alkene and carboxylic acid, characterised in that said carbon monoxide is maintained at between 1% and 20% by volume of the total feed to the oxidation reaction zone and possibly further comprising contacting in a second reaction zone at least a portion of said alkene and at least a portion of said carboxylic acid obtained from the oxidation reaction zone and a molecular oxygen-containing gas, in the presence of a catalyst to produce a second product stream comprising alkyl carboxylate.

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# INTERNATIONAL SEARCH REPORT

In Ional Application No
PCT/GB2004/002069

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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| Y | *the whole document; in particular, column 2, lines 57-64; column 3, lines 7-11 and 51-56; column 6, lines 16-28 and table 2* | 3,9-12,<br>14,15,22 |
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